National Climatic Data Center

DATA DOCUMENTATION

FOR

DATA SETs 3620 and 3640 (DSI-3620/3640)

Coastal Zone Color Scanner (CZCS)

March 24, 2003

National Climatic Data Center
151 Patton Ave.
Asheville, NC 28801-5001 USA

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1. Abstract: CZCS was a multi-spectral line scanner devoted principally to measurements of ocean color, which operated from November 2, 1978 to June 22, 1986. It had six spectral bands (channels), four of which were devoted to ocean color, each having a 20 nanometer bandwidth and centered at 443, 520, 550, and 670 nanometers. These are referred to as channels 1 through 4, respectively. Channel 5 sensed reflected solar radiance and had a 100 nanometer bandwidth centered at 750 nanometers and a dynamic range which was more suited to land. Channel 6 operated in the 10.5 to 12.5 micrometer region and sensed emitted thermal radiance for derivation of equivalent black body temperature.

This document describes the 1 km resolution Calibrated Radiance and Temperature Tape (CRTT) format Coastal Zone Color Scanner Level 1 data products archived at the Goddard Space Flight Center (GSFC) Distributed Active Archive Center (DAAC). Other CZCS data products archived at Goddard include 4 km resolution CZCS Level 1A & 2 products and 18 km resolution Level 3 composite products. The characteristics of the CZCS Sensor are described in the Coastal Zone Color Scanner Sensor Guide and the Nimbus 7 platform is described in the Nimbus 7 Platform Guide.

For most regions of the world, the color of the ocean is determined primarily by the abundance of phytoplankton and their associated photosynthetic pigments. As the concentration of phytoplankton pigments increases, ocean color shifts from blue to green. The Coastal Zone Color Scanner (CZCS, was a multi-spectral line scanner developed by NASA to measure ocean color as a means of determining chlorophyll concentrations and the distributions of particulate matter and dissolved substances.

The purpose of the CZCS on Nimbus-7 was to obtain a better understanding of the temporal and spatial distribution of phytoplankton biomass and primary production, and a better understanding of the processes regulating the growth of phytoplankton and of the processes influencing the ultimate fate of this organically fixed carbon. Satellite observations of ocean color were necessary to provide reliable estimates of marine phytoplankton biomass on synoptic scales which are useful in studies of phytoplankton processes. The mission objectives for the CZCS were to obtain observations of ocean color and temperature, particularly in the coastal zones, which would provide data with sufficient spatial and spectral resolution for the following applications:

- Measure concentrations of chlorophyll-a and phaeophytin.
- Map biologically productive areas.
- Map suspended sediment distribution and determine the type of materials suspended in the water.
- Map Gelbstoff (yellow substances) as an indicator of salinity.
- Detect pollutants in the upper level of the oceans.
- Map temperature of coastal waters and the open ocean.
- Study the interactions between coastal effluents and open waters.

2. Element Names and Definitions:

The original Level 1 CZCS data were produced and stored on 9-track magnetic tape in Calibrated Radiance and Temperature Tape (CRTT) format. In this original format, two files were created per scene: an EBCDIC header describing the data, and a data file containing the instrument scans. When these data were transferred onto digital optical disks, the files in CRTT Tape format were modified slightly to create files in CRTT Archive format. A major change was the combining of the separate files into one file and adding a format

header block. The Level 1 files archived and distributed by the Goddard DAAC are in this CRTT Archive format.

The CRTT Tape format has been retained for the most part. See the Nimbus-7 Coastal Zone Color Scanner Level 1 Data Product User's Guide (NASA TM 86203) for a complete description of the original CRTT Tape format.

The added format header block is the first 512 byte block in the file. This block was written on a VAX prior to being written on the platters. The files were then archived into the GSFC DAAC directly off of the optical platters. The header block contains 16-bit (2 byte) integers which only the first 16 are useful. Because the VAX writes to memory in Little Endian order, if you are on a machine which uses Big Endian order, you will have to swap the order of the bytes of the integers. Little Endian byte order puts the byte at the least significant positions in the word (the little end). Big Endian byte order puts the byte at the most significant position in the word (the big end). The DEC PDP-11/VAX and Intel 80x86 follow the Little Endian model, while the IBM 360/370 and Motorola 680x0, and others follow the Big Endian model. The byte swapping only applies to these first 16 integers of the header block. These bytes contain information on the format of the file. In the following description, each HEADER refers to a two byte integer:

```
HEADER( 1)      'magic' to signal archive header record
HEADER( 2)      'magic' to signal archive header record
HEADER( 3)      Length of data record (bytes)
HEADER( 4)      Number of documentation records (2 normally)
HEADER( 5)      First data record offset (blocks)
HEADER( 6)      Type code (101=CZCS)
HEADER( 7)      Number of data records (1-970)
HEADER( 8)      Orbit number
HEADER( 9)      Year of pass
HEADER(10)      Header record offset (blocks)
HEADER(11)      Header record length (bytes)
HEADER(12)      Documentation record length (bytes)
HEADER(13)      --
HEADER(14)      --
HEADER(15)      --
HEADER(16)      Scanner tilt (*100)
```

An example of the first 512 byte block from a CZCS level 1 file is (this was done on an SGI IRIX with the Unix octal dump command:
`od -x 79005164931.ni7 .`):

```
0000000 aaaa aaaa ec31 0200 1000 6500 d802 f703
0000016 bb07 0200 7602 d014 0000 0000 0000 5802
0000032 0000 0000 0000 0000 0000 0000 0000 0000
*
0001000
```

The variables translate to:

```
                  swapped
              hex   bytes  decimal  comments
              ---   -----  -------  --------
HEADER( 1) = aaaa   aaaa    43690   magic number
HEADER( 2) = aaaa   aaaa    43690   magic number
HEADER( 3) = ec31   31ec    12780   Length of record (bytes)
:
:
```

```
HEADER( 4) = 0200   0002        2   Number of documentation records
HEADER( 5) = 1000   0010       16   First data record offset (blocks)
HEADER( 6) = 6500   0065      101   type code (101=czcs)
HEADER( 7) = d802   02d8      728   number of records
HEADER( 8) = f703   03f7     1015   orbit number
HEADER( 9) = bb07   07bb     1979   year
HEADER(10) = 0200   0002        2   header record offset (blocks)
HEADER(11) = 7602   0276      630   header record length (bytes)
HEADER(12) = d014   14d0     5328   documentation record length (bytes)
HEADER(13) = 0000   0000        0   ---
HEADER(14) = 0000   0000        0   ---
HEADER(15) = 0000   0000        0   ---
HEADER(16) = 5802   0258      600   scanner tilt (*100)
```

From this example the layout of the file is:

bytes	comment
0-31	File description.
1024-1654	Header information. Start at HEADER(10) and is HEADER(11) length. This information is EBCDIC.
2048-7376	Documentation record. Start at next block and is HEADER(12) length.
8192-20972	First record. Start at HEADER(5) and is HEADER(3) length.
20992-33772	Next record. Start at next 512 byte block and HEADER(3) length. Continue for a total of HEADER(7) records.
9326592-9332224	The trailing documentation record. The last 304 bytes are null characters. This file is padded out to be an even multiple of 512 to keep integrity of the 512 byte blocks.

Level 1 data contain at-spacecraft raw radiance counts with calibration and Earth location information appended, but not applied. Visible and infrared radiances were measured in six spectral channels. The spectral region and band widths of the six channels and primary use of each are indicated in the following table:

Channel	Spectral Band (micrometers)	Primary purpose
1	0.433 - 0.453	Chlorophyll absorption
2	0.510 - 0.530	Chlorophyll correlation
3	0.540 - 0.560	Yellow substance (Gelbstoff)
4	0.660 - 0.680	Aerosol correction
5	0.700 - 0.800	Land/cloud flag
6	10.5 - 12.5	Surface temperature; failed shortly after launch

Unit of Measurement:

Level 1 Calibrated radiances were measured in units of mW/(cm2.sr.micron) with 1 km x 1km resolution

Data Source: CZCS was flown aboard the Nimbus-7 satellite.

3. Start Date: 19781102

4. Stop Date: 19860622

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5. **Coverage**: Spatial Coverage is global with an emphasis on coastal regions. Spatial coverage varied widely and was very irregular.

6. **How to Order Data**:

Ask NCDC's Climate Services about the cost of obtaining this data set.
Phone: 828-271-4800
FAX: 828-271-4876
E-mail: **NCDC.Orders@noaa.gov**

The Goddard DAAC is the central archive and distribution facility responsible for providing access to the entire CZCS data set. The entire collection of Coastal Zone Color Scanner (CZCS) ocean color data and images is available on-line via the World Wide Web in the Data Section of the NASA Goddard DAAC Ocean Color Data and Resources Website at

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/OB_main.html

Users may view Level 2 browse images of 59,337 CZCS files and place FTP or tape orders with the Goddard DAAC for those CZCS data products they desire. Each Level 2 browse file maps to corresponding Level 1 and 1A files. All Level 1A and 2 files are also available via anonymous ftp. CZCS Level 1 files are orderable via the Browser but do not reside online due to the size of the Level 1 collection.

7. **Archiving Data Center**:

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

8. **Technical Contact**:

CZCS Data -
Dr. Gene Feldman
Goddard Space Flight Center, Code 902.3
Greenbelt, MD 20771
(301)286-9428
email: gene@seawifs.gsfc.nasa.gov

Software -
Dr. Bob Evans
University of Miami, RSMAS/MPO
4600 Rickenbacker Causeway
Miami, FL 33149
(305)361-4799
email: bob@rrsl.rsmas.miami.edu

9. **Known Uncorrected Problems**: The internal metadata in the header and trailer documentation records for Level 1 files is known to be erroneous in several instances. The Goddard DAAC's database has been corrected, but the individual header and trailer records have not been corrected.

10. Quality Statement: Some Level 1 scenes were flagged as containing unreliable data and were not included in the Level 3 composites but are still available from the Goddard DAAC. During ingest into the Goddard DAAC, metadata contained in the Level 1 files were accessed and used to produce a comprehensive and consistent database for all CZCS holdings. Many duplicate files and errors were eliminated in this first effort. In 1996 the metadata themselves were reviewed uncovering several types of navigational errors. Based on that analysis the database was updated and corrected again. The corrected data base entries now provide the framework for operational Browse and request processing.

11. Essential Companion Datasets: None.

12. References:

For further details on the CZCS sensor and the Nimbus 7 satellite, please consult The Coastal Zone Color Scanner Instrument Guide,

(http://eosdata.gsfc.nasa.gov/SENSOR_DOCS/CZCS_Sensor.html)

and the Nimbus 7 Platform Guide,

(http://podaac-www.jpl.nasa.gov:2031/SOURCE_DOCS/nimbus7.html).

"CZCS Sensor Guide Document", prepared by the Distributed Active Archive Center, NASA Goddard Space Flight Center, Greenbelt, Maryland, 1995.

"Ocean Color From Space", Prepared by the US Global Ocean Flux Study Office with contributions from NASA Goddard Space Flight Center, Wood's Hole Oceanographic Institution, the University of Miami and the University of Rhode Island. HTML version published by the Distributed Active Archive Center, NASA Goddard Space Flight Center, Greenbelt, Maryland, 1995.

"The Living Ocean: Observing Ocean Color From Space", NASA Publication PAM-554, Goddard Space Flight Center, Greenbelt, Maryland, 1993.

"Coastal zone color scanner 'system calibration': A retrospective examination." R.H. Evans & H.R. Gordon, Journal of Geophysical Research, Vol.99. No. C4, pages 7293-7307, April 15, 1994.

"Coastal Zone Color Scanner", European Space Research Institute, Frascati, Italy.

Nimbus 7 Coastal Zone Color Scanner (CZCS) Level 1 Data Product Users' Guide NASA TM 86203, S.P. Williams, E.F. Szajna and W.A. Hovis. Goddard Space Flight Center, Greenbelt, MD 20771. July, 1986, 53 pages.